Management of Incidental Lung Nodules
Current Strategy and Rationale

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KEYWORDS

• Incidental nodule • Lung nodule • Fleischner Society • Nodule management • Subsolid • Computed tomography

KEY POINTS

- Incidental lung nodules often require additional evaluation in a manner that balances risk of clinically relevant disease, patient anxiety and inconvenience, and overimaging.
- The Fleischner Society has recently published updated management guidelines for solid and subsolid lung nodules incidentally detected on computed tomography (CT).
- Lung nodule size remains the primary factor that determines the likelihood of malignancy. Nodule attenuation, morphology, and location factor into the determination of malignancy probability.
- Continued technological advancements in CT imaging show promise in differentiating potentially malignant nodules, based on quantitative features such as nodule volume and texture analysis.

INTRODUCTION

Lung nodules incidentally detected on computed tomography (CT) comprise a large and complex group of pathologic entities that often require additional evaluation. Whether discovered on CT of the neck, chest, or abdomen, these lung nodules are identified in conjunction with or in the absence of other diagnostic imaging findings. This is in clear distinction to nodules discovered in the context of lung cancer screening, in which high-risk current and former smokers undergo formal evaluation with the specific goal of identifying early-stage lung cancers. Extensive literature from numerous lung cancer screening programs address lung nodule management in a high-risk screening population. Screening studies include the National Lung Screening Trial, International Early Lung Cancer Action Program, Canadian screening studies Pan-Canadian Early Detection of Lung Cancer Study (PanCan) and British Columbia Cancer Agency, and the European Nederlans-Leuvens Longkanker Screenings Onderzoek (NELSON) screening trial. Although some screening data can be applied to incidentally discovered lung nodules, these incidental nodules must be managed in an appropriate manner that balances risk of clinically relevant disease, undue patient anxiety and inconvenience, and overimaging.

Recently revised management guidelines for incidental lung nodules have been published by the Fleischner Society, an international multidisciplinary group of scientists that includes thoracic radiologists, pulmonologists, surgeons, and pathologists.[1] These guidelines have been recently updated in a continued effort to integrate advancements in knowledge and to appropriately balance the risk of clinically significant disease with the management preferences of clinicians and patients. Recommendations are determined by the risk of malignancy of incidental lung nodules, which can be inferred from data such as

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nodule size, morphology, and attenuation (ie, solid vs subsolid). Fleischner Society management guidelines typically apply to adult patients older than 35, as younger patients are less likely to develop lung cancer; patients without underlying malignancy, as oncologic patients can have metastases; and immunocompetent individuals, as immunocompromised patients are susceptible to lung infection. The advisory group stresses the importance of using these recommendations in the full clinical context of the patient's potential comorbidities and preferences, while allowing more flexibility in recommendations by radiologists and compliance by clinicians.

The goal of this article is to review important recommendations and changes made by the Fleischner Society to their management guidelines for incidental lung nodules on CT images, as these guidelines create the standard by which incidental nodules are evaluated and managed. Relevant literature pertaining to risk of nodule malignancy is reviewed in the context of a nonscreening population, and future directions are explored.

FLEISCHNER SOCIETY MANAGEMENT GUIDELINES: COMPLIANCE

Awareness of and adherence to Fleischner Society guidelines for management of incidental pulmonary nodules have improved over time. In a survey of members of the Radiological Society of North America, 77.8% of respondents were aware of the recommendations, and nearly 60% of respondents worked in a practice that advocated such guidelines. A significantly higher rate of concordance between radiologist recommendations and Fleischner guidelines was found in academic settings, practices with a written policy available for viewing at work, in groups with at least one dedicated fellowship-trained thoracic radiologist, and among radiologists with fewer than 5 years of practice experience.[2] Other literature has reported low adherence to established guidelines, with one group documenting 34% of recommendations adherent to Fleischner guidelines in a real-world working environment that included both emergency department and outpatient clinics.[3] Noncompliance contributing to overmanagement of small incidental nodules also has been documented.[4,5] Adherence may simply be a matter of mindfulness, with one radiology group's adherence to guidelines as high as nearly 83% after formal discussions and institutional guidelines emphasizing the importance of standardized recommendations.[6] Increased awareness also has strengthened compliance by clinicians and patients. Increased likelihood of nodule surveillance was associated with direct communication of imaging results to the referring physician or the patient, in addition to the recommendation of a specific CT follow-up time interval by the radiologist.[7] Furthermore, in an age of increasing flexibility and customization of imaging and reporting systems, including the recommendation template with the imaging report may improve compliance with follow-up recommendations by clinicians and their patients. Although only 39% of patients received follow-up imaging as recommended in one reported patient population, those patients were significantly more likely to undergo follow-up when recommendation templates were included in CT reports.[8]

FLEISCHNER SOCIETY MANAGEMENT GUIDELINES: UPDATES

Current Fleischner Society recommendations update guidelines pertaining to both solid and subsolid nodules.[9,10] Rather than specific follow-up imaging intervals, current guidelines now provide a time range, providing greater discretion not only to radiologists who may suggest sooner follow-up for suspicious nodule morphology, for example, but also to clinicians and patients who are more attuned to underlying patient history and preferences. Additional recommendations also are provided for multiple solid and subsolid nodules, as multiplicity may alter the frequency and duration of surveillance. It follows that management for patients with multiple incidental nodules should be guided by the largest or most suspicious-appearing nodule (**Fig. 1**).

IMAGING CONSIDERATIONS

Appropriate management of incidentally detected lung nodules is based on accurate, high-quality imaging. CT imaging should incorporate thin-section axial images on the order of 1.5 mm or smaller to minimize volume averaging, allow improved nodule detection, and enable accurate characterization of nodule size, morphology, and attenuation[11] (**Fig. 2**). Thin-section images also facilitate reconstruction of multiplanar coronal and sagittal images, which can be useful in discriminating nodules from oblique areas of linear scarring or atelectasis (**Fig. 3**). Intravenous contrast is typically not needed for accurate detection and evaluation of lung nodules. In patients who require follow-up imaging, low-dose CT technique is important to reduce cumulative patient radiation dose. The Fleischner guidelines recommend volumetric CT dose index of no more than 3 mGy for a standard-size patient, the